PATENT SPECIFICATION

DRAWINGS ATTACHED

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1,075,473

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Int. Cl.:—B 32 b//B 29 d, f, F 16 j

COMPLETE SPECIFICATION

Sintered Plastic Articles

We, THE DURIRON COMPANY, INC., of Dayton 1, Ohio, United States of America, a Corporation of the State of New York, United States of America do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the fabrication of laminated members of a sintered plastics material.

Fluorocarbon polymers which are available commercially in powdered form, such as tetrafluoroethylene resins sold under the trademark Teflon, may be fabricated into articles by performing under pressure to compact the powder to the desired shape followed by sintering or baking at a relatively high temperature to produce a finished product. These sintered plastics have excellent bearing properties even in the absence of a lubricant, and they have the additional advantage of being highly inert and are therefore useful for sealing purposes, particularly where corrosive materials are involved. However, they also have a definite tendency to cold flow under load, especially at elevated temperatures, and the resulting changes in shape and dimensions affect their utility in structural members.

It is an object of this invention to provide a structural member in the form of a laminated article wherein a relatively thin sheet of plastics material is secured to and maintained in intimate contact with a flexible backing member in such a manner as to provide an interlocked unitary structure which is stable after continued and repeated flexing.

To this end, the invention consists in an article of manufacture comprising a body of sintered plastics material having one surface formed with upstanding integral nibs, an overlying flexible polymeric or elastomeric backing member having multiple recesses in one surface thereof into which the nibs of the sintered material project, and an adhesive material interposed between said backing member and said plastics body and co-operating with said recesses and nibs to secure said body in maintained intimate contact with said backing member.

The invention also consists in a method of making such an article, including providing a nibbed member of sintered polytetrafluoroethylene, applying an adhesive to the nib surface of said member, placing a body of uncured material consisting of thermosetting or thermoplastic material or combinations thereof in contact with said adhesive coated nibbed surface, and exposing said thus prepared materials to heat and pressure for curing and causing adhesion therebetween.

The article may be formed into various desired shapes including spherical and cylindrical for example.

In order that the invention may be more readily understood, reference will now be made to the accompanying drawing, in which:—

Fig. 1 is a view in section of an article produced in accordance with this invention and comprising a flexible backing member bonded to a sintered plastics member;

[Pri

Figs. 2 and 3 are somewhat diagrammatic views illustrating successive steps in the fabrication of the nibbed sintered plastic member;

Fig. 4 is a plan view on an enlarged scale of the nibbed surface of the sintered plastic member;

Fig. 5 is a view in section on an enlarged scale of one of the nibs shown in Fig. 4;

Fig. 6 is a somewhat diagrammatic view of the final step of the fabrication of the article shown in Fig. 1;

Fig. 7 is a view in perspective, with parts thereof broken away, of a diaphragm member fabricated in accordance with the present invention;

Fig. 8 is a view partly in section and partly in elevation taken generally along the line 8—8 of Fig. 7;

Fig. 9 is a somewhat diagrammatic view illustrating the final step in the fabrication of the diaphragm member shown in Fig. 7;

Fig. 10 is an enlarged sectional view taken generally along the line 10—10 of Fig. 9; and

Fig. 11 is a view in perspective, with parts thereof broken away, of a resilient cup-shaped member having an outer surface of sintered plastic material in accordance with the invention.

Referring to the drawing, which illustrates a preferred embodiment of the present invention, the article 20 shown in Fig. 1 includes a flexible backing member 22 of rubber or flexible thermoplastic or thermosetting material, such as silicone rubber, polyurethane, a styrene butadiene resin an epoxy resin, butadiene-acrylonitrile, polyethylene, polypropylene, polystyrene, a vinyl polymer, a vinyl copolymer or a chlorinated rubber. The backing member 22 is bonded to a layer 24 of sintered plastics material by means of a multiplicity of nibs 25 or integral projections which are seated in a corresponding number of recesses formed in one surface of the backing member.

Figs. 2, 3 and 6 illustrate in schematic fashion the steps involved in fabricating the article of Fig. 1, which include forming a nibbed sheet of "Teflon", degrading the nibbed surface of the sheet to provide a wettable surface which is receptive to an adhesive, and simultaneously curing and bonding a flexible backing member to the sintered plastics member.

The initial step in fabricating the nibbed sheet 24 involves placing in the bottom of a suitable mold 30 a metal plate 31 having a plurality of perforations 32 therein, and then adding the powdered resin material 33 until a layer of sufficient thickness is present, depending on the desired thickness of the sheet. The plunger 34 is then actuated to perform the powder 33 by compaction within the mold which reduces the thickness of the composite materials as much as 4—6 to 1. The resulting preformed composite article is then subjected to the proper elevated temperature to effect sintering of the compact powder, an appropriate temperature being in excess of 620°F in the case of the "Teflon" material noted above.

Subsequent to the sintering operation, the nibbed plastics sheet 24 is stripped away from the perforate metal plate 31, as shown in Fig. 3, to provide a sintered plastics member having a plurality of nibs formed in one surface thereof as shown in Fig. 4. The locking nibs 25, which are in the form of integral projections on one surface of the sintered plastics member, are preferably formed in parallel rows with the nibs of one row evenly spaced from the nearest two nibs of the adjacent row. The number of nibs per square inch should be such that a sufficient portion of the non-nibbed surface is exposed for bonding and with a sufficient number of nibs to provide good adhesion with the flexible backing member. As an illustration and in no way to be construed as a limitation, there may be from about 80 to 160 or more nibs per square inch, with the average nib diameter at the base thereof ranging from about less than 1/16 to 1/8 inch or more.

Fig. 5 shows a nib configuration which serves to provide particularly efficient bonding. It will be seen from this figure that the nib 25 is thinner at its midsection 40 than at either end thereof. The reason for such nib configuration can be understood with reference to the sheet forming techniques and the characteristics of the powdered starting material as now explained.

In forming the sheet 24, there is a greater thickness of powder in each part of the layer of material 33 overlying one of the perforations 32 (Fig. 2) than in the parts overlying the imperforate portions of metal plate 31. Since the powdered material possesses a substantial resistance to lateral displacement, the result is that during the preforming step, the powder is more highly compacted in the parts of the layer overlying the imperforate portion of the plate 31 than in the parts overlying the perforations 32, as is more fully explained in U.S. Patent No. 2,976,093.

The differential compacting which occurs during the preform operation, in addition to establishing a density differential, also forces the powdered material into the apertures 32 in such fashion as to cause the density of each nib to be greater in the tip portion and base than in the area approximately in the midsection of the nib. Further, the density of the sintered plastics material overlying the imperforate areas of plate 31 is greater than the density of the material overlying and filling the perforations 32. Accord-

ingly, as the sintered plastics sheet 24 is stripped or removed from the perforate plate 31, the individual nibs tend to expand along the tip portion to provide a nibbed configuration wherein each nibbed portion is thinner in cross-section at the middle portion thereof than at either end.

The nibbed plastics sheet fabricated as above described may be bonded to a flexible backing member, and the composite assembly cured or formed into the desired configuration in a single step operation. In order to provide a chemical bond, the nibbed surface of the plastics member is pretreated to improve the wettability or the receptivity of the surface to the adhesive. On such method of pretreating the sintered plastics material includes exposure of the nibbed side of the plastics sheet to a solution of sodium in anhydrous liquid ammonia for a period of time sufficient to cause degradation of the nibbed surface as indicated by the change in color thereof from milky white to dark brown.

Subsequent to treatment of the nibbed surface, the sintered plastics sheet 24 is placed in a mold 50 as shown in Fig. 6 with the smooth side of the sheet contacting the base 52 of the mold. The adhesive, which may for example, be an epoxy cement or one of the cements conventionally used in the rubber industry to bond rubber materials, may be applied before or after the plastics sheet is placed in the mold, although it is preferred that the adhesive be applied prior to inserting the plastic sheet 24 into the mold, since this facilitates the application of the adhesive. Thereafter, an uncured thermoplastic or thermosetting material 54, such as rubber or any of the well known plastics capable of providing a flexible backing is placed over the sheet 24. Pressure is applied by the plunger 56 and the mold heated to a temperature sufficient for simultaneously curing the uncured material 54, causing adhesion between the sintered plastics sheet 24 and the material 54 and forming the composite structure into the desired shape. The resulting article is then removed from the mold to provide a flexible laminate having a sintered plastics facing as described in connection with Fig. 1.

The number of nibs per square inch, the diameter, and the length of each nib are selected so as to provide a strong bond between the sintered plastics sheet 24 and the backing member 22. The thickness of the non-nibbed portion of the sheet 24 may be varied with the desired need, and in accordance with this invention it is possible to provide a laminated article having a plastics sheet 24 which is 0.030 inch in thickness securely and permanently fastened to a flexible backing member 22. It is also possible in accordance with the present invention to fabricate articles having a sintered plastics sheet of several inches thickness secured to a backing member.

A further advantage accruing from the use of a nibbed sheet fabricated as above described results from the significant increase in total surface area provided by the additional surface area of each nib. Such addition surface area is effectively utilized in accordance with the present invention by employing an adhesive which is placed on the surface of the nibbed sheet prior to fabricating the finished product. This increased surface area provided by the presence of the multiplicity of projections on the one surface of the sintered plastic sheet, in addition to providing a mechanical bond, also increases the surface exposed for chemical and adhesive bonding. Thus the strength of the bond achieved through the use of an adhesive and a nibbed sheet is greater than that possible by merely affixing a non-nibbed plastics sheet to a backing member.

One aspect of this invention concerns the formation of laminated articles having a surface or a portion of a surface which is contoured. Referring to Figs. 7 and 8, a diaphragm member 60 of generally rectangular shape is shown as including a flexible backing member 62 and a sintered plastics member 64 having nibs 65 thereon. A plurality of holes 66 are provided, one at each corner of the diaphragm for securing the diaphragm in position. While the diaphragm 60 is shown of generally rectangular configuration, it is understood that it may be of any shape or size, as is well known in the art.

Positioned in the center of the dished portion 68 of the diaphragm is a boss 70 which serves to anchor a threaded stud 72 to the diaphragm, thus permitting the diaphragm body to be moved relative to the seat upon which it is fixed. If desired, the flexible backing member 62 may be provided with a fabric reinforcing layer therein, as is well known in the art. The provision of the multiplicity of nibs 65 and the use of an adhesive as already described serves to secure the flexible backing member 62 to the sintered plastics member 64 by an exceptionally stable and strong bond, especially in the curved portion of the diaphragm.

The dished portion 68 of the diaphragm is of a spherical shape, and the nibs 65 are arranged so that they are substantially perpendicular to the surface, in the case of a planar surface, or approximately perpendicular to the tangent at the point of contact between the plastics sheet and the backing member in the case of a curved surface. Thus, as force is applied axially of the stud 72, by pulling on the stud 72, the nibs 65 which are disposed in a plane perpendicular to the stud 72 rather than parallel to the stud, serve to maintain the backing member and the plastic member in a bond tightly together.

Any tendency of the nibs in the plane perpendicular to the stud 72 to separate from the backing member, for example those nibs below the boss 70, is reduced by the provision of the dovetail lock arrangement described in connection with Fig. 5.

In the fabrication of the diaphragm 60, a planar sheet 64 of sintered plastics is placed in a mold 75 with the smooth surface of the sheet facing downward to expose the nibs 65, as shown in Figs. 9 and 10. Thereafter a layer 77 of adhesive is applied to the nibbed surface of sheet 64, although it is understood that the adhesive may be applied prior to placing the sheet 64 in the mold. A sheet 62 of uncured material, such as rubber or the like is then placed on the adhesive coated plastics layer. The stud 72 is placed on the surface of the uncured sheet 62, and the composite assembly is heated while pressure is applied to form the dished portion 68 of the diaphragm by causing the material to move into the mold cavity 80. In this single operation, the layer 62 is cured and caused to adhere to the plastics layer 64 while the composite assembly is formed into the desired configuration.

The advantages of having a portion of the nibbed sheet arranged in a plane parallel to the direction of the applied force may be more clearly understood with reference to Fig. 11, which shows a cup-shaped member 90 adapted to be employed as a flexible, yieldable, self-lubricating piston in pumps handling air or corrosive materials.

Surrounding and bonded to an inner flexible backing member 92 is a sintered plastics member 94 having a multiplicity of locking nibs 95 which penetrate into the backing member 92 and cooperate with a suitable adhesive to provide a uniform and efficient bond between the two members. The piston 90 may be affixed to a piston rod by a stud (not shown) positioned on and secured to the inner face 96 of the base portion 97.

The piston 90 normally moves in reciprocating fashion since the force is applied parallel to the plane of its cylindrical wall, and thus the majority of the nibs 95 are disposed in a plane parallel to the direction of the applied force, and extend inwardly perpendicular to the direction of such applied force. With this arrangement of the majority of the nibs 95 in relation to the direction of applied force, it can readily be understood that there is little tendency of the nibs along the cylindrical wall of the piston to separate from the backing member 92. As to the base portion 97, the dove-tail configuration of the nibs, and the presence of an adhesive serve to reduce the possibility of separation of the flexible backing member and the plastics member.

If desired, the thickness of the backing member 92 in the area of the base 97 may be substantially increased so that the effects of the applied force are taken up by backing member 92, and little if any force is exerted at the interface of the backing member and the plastics member along the base portion 97. In the alternative, the plastics member may be secured to a solid elastic compressible plug by molding the nibbed sheet into desired shape, and subsequently, in a single operation curing the plug and causing it to adhere to the sintered plastics member.

While the methods and articles herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise methods and articles, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

WHAT WE CLAIM IS:—

1. An article of manufacture comprising a body of sintered plastics material having one surface formed with upstanding integral nibs, an overlying flexible polymeric or elastomeric backing member having multiple recesses in one surface thereof into which the nibs of the sintered material project, and an adhesive material interposed between said backing member and said plastics body and co-operating with said recesses and nibs to secure said body in maintained intimate contact with said backing member.

2. An article as claimed in claim 1, wherein each said nib has a base portion and tip portion of cross-section greater than the cross-section through the mid-section of said nib.

3. An article as claimed in claim 1 or 2, wherein said plastics body is of greater density in the portions thereof located between said nibs than in the portions thereof forming said nibs.

4. An article as claimed in any of the preceding claims, in which said article is a diaphragm and said backing member is an elastomeric material, and said sintered plastics material is polytetrafluoroethylene, said backing member including a boss on the surface thereof opposite said sintered plastics material, and stud means positioned within said boss.

5. An article as claimed in claim 4, wherein said article includes a dished central portion adapted to be flexed repeatedly.

6. An article of manufacture substantially as hereinbfore described with reference to the accompanying drawings.

7. A method of making an article as claimed in any of the preceding claims, including a nibbed member of sintered polytetrafluoroethylene, applying an adhesive to the nib surface of said member, placing a body of uncured material consisting of thermosetting or thermoplastic material or combinations thereof in contact with said adhesive coated nibbed surface, and exposing

said thus prepared materials to heat and pressure for curing and causing adhesion therebetween.

8. A method as claimed in claim 6, wherein the application of heat is also used to form said thus prepared materials into the desired shape.

9. A method of making an article substantially as hereinbefore described with reference to the accompanying drawings.

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Chartered Patent Agents

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1075473 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG-1

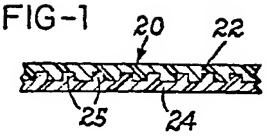

FIG-2

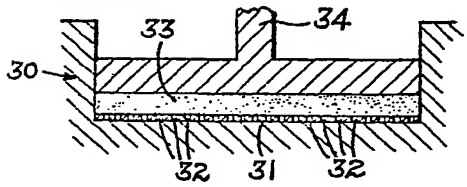

FIG-3

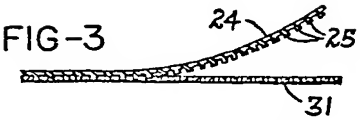

FIG-4

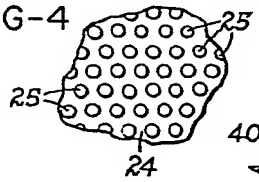

FIG-5

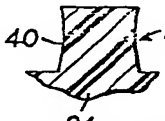

FIG-6

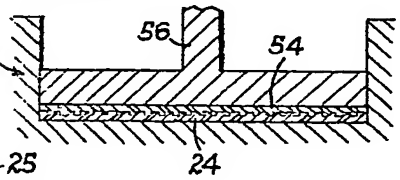

FIG-7

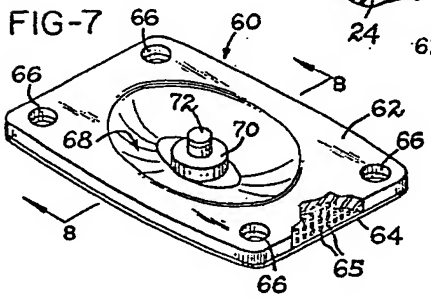

FIG-8

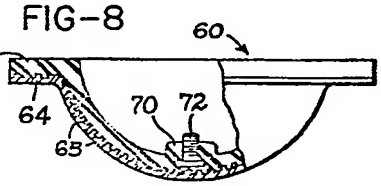

FIG-10

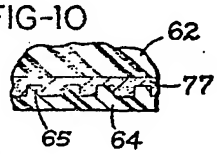

FIG-11

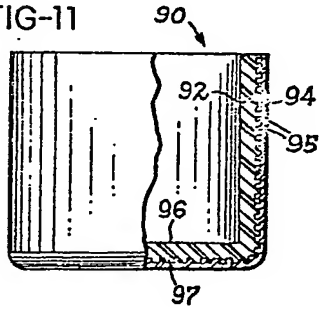

FIG-9